PREVALENCE OF MUSCULOSKELETAL SYMPTOMS AND ERGONOMIC RISK ASSESSMENT AMONG PRODUCTION WORKERS IN MANUFACTURING INDUSTRIES

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A thesis submitted in
fulfilment of the requirement for the award of the
Master in Mechanical Engineering

Faculty of Mechanical and Manufacturing Engineering
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JULY 2020

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"Special thanks to my beloved parents and siblings for their love, supervisor and brotherhood friends for advices and undying support in the encouragement toward the success of this study. The sacrifices and encouragement will be etched in the hearts FOREVER"

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ACKNOWLEDGEMENT

Praise to God, The Most Merciful, The Most Compassionate, for granting author the chance and strength to complete this thesis for Degree of Master, which undoubtedly bring author into heights of intellectual and emotional enrichment. The author also like to take this opportunity to give author's respected supervisor Dr. Mohd Nasrull bin Abdol rahman, a million thanks for the support and guidance through the year in completing this research.

The author also appreciates all the UTHM staff who gives full commitment and support by helping the author on making the project success. The last but not least, the author would like to thank to all the friends who also give support and guidelines when doing this research. The author would like to thanks parents who give endless contribution morally and financially.

"Life is a learning process."

Thank you.

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ABSTRACT

Production worker's job in manufacturing industries is one of the occupations that risk to Musculoskeletal Symptoms (MSSs) such as awkward postures, repetition motion, and forceful exertions which as causes to serious musculoskeletal injuries. The aim of this study is to identify the prevalence of MSSs and Ergonomic Risk Factors (ERFs) among production workers. This study was conducted using Nordic Musculoskeletal Questionnaire (NMQ) as an interviewing method while Entire Body Risk Assessment (ENBORA), Rapid Entire Body Assessment (REBA) and Quick Exposure Check (QEC) as a direct observational tool. A total of 252 production workers from various manufacturing industries were selected as samples in this case study. Mostly, the age of production workers working there were between 21-30 years old with a percentage of 62.7%. Based on the NMQ results, it showed that most of the workers dealt with lower back (68.7%), shoulder (52.0%), upper back (51.6%) and hands/wrists (50.8%). For QEC tool, all workers were found to have Moderate exposure level except for the back region which for movement tasks with High exposure level (mean=31.18, SD = 6.604). Based on REBA tool, the risk factors on trunk and upper arm were most experienced by workers which put the REBA risk level in High (mean=9.98, SD = 2.430) meanwhile for ENBORA tool, the production workers experienced Medium exposure level mainly from hand/wrist. Pearson Chi Square test was conducted to determine the correlation between NMQ variables and Ergonomic Risk Level. The results indicated there was association between NMQ variables and Ergonomic Risk Level. In conclusion, the high Ergonomic Risk Level among production workers has significantly contributed to harmful exposure and developments of MSSs. Risk factors such as awkward posture, task duration, repetitive motions and heavy physical work must be avoided. The information from this study also suggested to use REBA tool as best way to assess the level of an ergonomic risks at production in manufacturing industries.

ABSTRAK

Pekerjaan seorang perkerja produksi di industri pembuatan adalah salah satu pekerjaan yang membawa risiko Gejala Muskuloskeletal(GM) seperti postur abnormal, gerakan berulang dan pengerahan tenaga yang kuat dan ai sebagai penyebab kecederaan muskuloskeletal. Tujuan kajian ini adalah untuk mengenal pasti kelaziman Gejala Muskuloskeletal dan Faktor-faktor Risiko Ergonomik kepada pekerja produksi dalam industri pembuatan. Kajian ini dilakukan dengan menggunakan *Nordic Musculoskeletal Questionnaire* (NMQ) sebagai kaedah soal selidik manakala E*ntire Body Risk Assessment* (ENBORA), *Rapid Entire Body Assessment* (REBA) dan *Quick Exposure Check* (QEC) sebagai kaedah pemerhatian. Seramai 252 perkerja produksi dari pelbagai industri pembuatan telah dipilih sebagai sampel dalam kajian kes ini. Kebanyakkan usia perkerja produksi ini adalah di antara 21-30 tahun dengan peratusan 62.7%. Berdasarkan keputusan NMQ, ia menunjukkan sebahagian besar perkerja produksi mengalami gangguan pada lumbar (68.7%), bahu (52.0%), belakang dada (51.6%) dan di tangan/pergelangan tangan (50.8%). Untuk kaedah QEC, tahap pendedahan risiko adalah Sederhana kecuali pada belakang badan untuk tugasan pergerakkan iaitu mempunyai pendedahan risiko yang Tinggi (Nilai Purata=31.18, SD=6.604). Untuk kaedah REBA pula, bahagian belakang badan dan lengan atas menunjukkan bahawa kebanyakan mereka yang berpengalaman dalam faktor-faktor risiko dan ini menyebabkan risiko REBA berada dalam risiko yang tinggi (Nilai Purata=9.98, SD=2.430) manakala untuk kaedah ENBORA, ia menunjukkan pendedahan risiko yang Sederhana terutamanya pada tangan/pergelangan tangan. Ujian Pearson Chi Square telah dijalankan untuk menentukan korelasi antara pembolehubah NMQ dan Tahap Risiko Ergonomi dan keputusan menunjukkan terdapat hubungannya. Kesimpulannya, Tahap Risiko Ergonomik yang tinggi di kalangan pekerja pengeluaran telah banyak menyumbang kepada pendedahan dan perkembangan GM yang berbahaya. Faktor risiko seperti postur yang janggal, tempoh tugas, gerakan berulang dan kerja fizikal berat harus dielakkan. Maklumat dari kajian ini juga mencadangkan untuk menggunakan penilaian REBA untuk menilai tahap risiko ergonomik pada pengeluaran dalam industri perkilangan.

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LIST OF SYMBOLS AND ABBREVIATIONS

K	-	Cohen's Kappa Coefficient
N	-	Population of study
n	-	Sampling Size
Q	-	Proportion of attrition
SD	-	Standard Deviation
X	-	Mean
±	-	Plus-Minus
%	-	Percentage
α	-	Alpha
$\chi 2$	-	Chi Square
p	-	Pearson Chi-Square
r	-	Spearman Correlation Coefficients
po	-	Observed Agreement,
pe	-	Expected Agreement
DOSH	-	Department of Occupational Safety and Health
MSSs	-	Musculoskeletal Symptoms
NIOSH	-	National Institute of Occupational Safety and Health
OSHA	-	Occupational Safety and Health Administrative
NMQ	-	Nordic Musculoskeletal Questionnaire
ENBORA	-	Entire Body Risk Assessment
QEC	-	Quick Exposure Check
REBA	-	Rapid Entire Body Assessment
SPSS	-	Statistical Package for the Social Sciences
WMSDs	-	Work-related Musculoskeletal Disorders

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Musculoskeletal symptoms (MSSs) in a working population is the most common and leading cause of occupational injury and disability in developed and industrial developing countries (Mohammadi, 2013). These symptoms had a multiple factor ecology with physical and psychosocial risk factors (Bongers *et al*., 2006). In Malaysia, a total of 4,034 cases have been successfully investigated for the purpose of carrying out improvements to the workplace in terms of occupational health. The number of cases reported for Musculoskeletal Symptoms (MSSs) from the year 2008 to 2015 rose every year and in the year 2015, there were 208 musculoskeletal symptoms cases reported from January to August (DOSH, 2016). Figure 1.1 shows the number of cases of occupational disease and poisoning for the year 2015 (January - August).

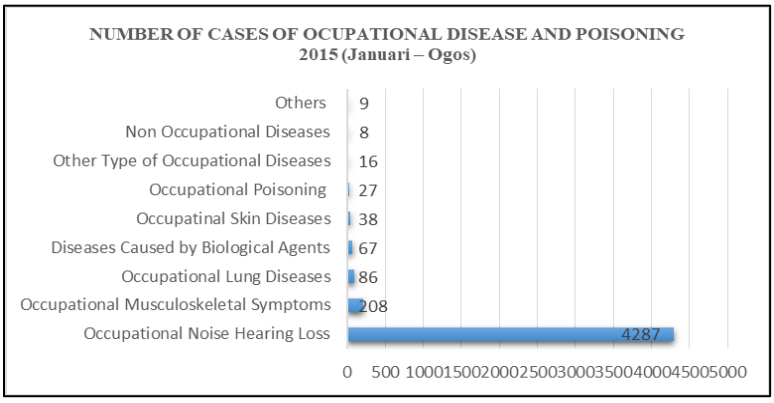

Figure 1.1: The number of cases of occupational disease and poisoning 2015 (January - August) (DOSH, 2016)

In the case of musculoskeletal pain, industry workers sometimes complained that their whole body became overworked or pulled, and the causes of musculoskeletal pain varied from one body to the other. The wear and tear of everyday activities in industries have caused musculoskeletal symptoms. Postural stress, repetitive movements, and prolonged immobilisation are some of the other causes. Changing postures or body mechanics may lead to spinal alignment, muscle abrasion and other muscles which are abused and painful. Precise measurement of worker exposure to factors that can contribute to Work-related Musculoskeletal Symptoms Disorders (WMSDs) development of crucial important for research study ergonomists and also for the measurement of risk factors, as a basis for risk prevention and reduction schemes. The objective of an ergonomic assessment is to determine the ergonomic risk for the job assessment. These evaluations are proposed to reduce worker's ergonomic risks or symptoms of the musculoskeletal system. A plan for prioritizing and implementing measurable workplace improvements was developed by quantifying ergonomic risk factors which included Entire Body Risk Assessment (ENBORA), Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA), Quick Exposure Check (QEC), and so on. All assessments had a function of their own to measure risk factors including physical, psychological and sociodemographic aspects. Physical ergonomics such as load and posture, awkward work position, heavy lifting weight, handling of manual materials, longer standing and walking times and poor working conditions were all associated with musculoskeletal symptoms (Van Der Windt *et al*., 2000).

Manufacturing industries have been the driving force behind economic growth, structural change and catch-up (Naudé & Szirmai, 2012). The higher productivity growth potential of manufacturing industries benefits from the capacity of the sector to accumulate greater levels of capital, economies of scale, and technological advances in agriculture and some services (Haraguchi *et al.*, 2017). In the majority of nations, the benefits of manufacturing industries helped to create job opportunities for people. Due to the presence of numerous industries, people are used to various products such as TV, clothes, cars, furnishings and others that facilitate and improve our life in general. Furthermore, many workers are facing musculoskeletal disorders due to unsuitable working styles which lead to another inconvenience for the industry (Kifle *et al.*, 2014). A case study carried out in printing manufacturing industries which

involved a total of 250 printing production line workers with the response rate of 85.9%. The study found that the prevalence of musculoskeletal symptoms was 79.6% (Foong *et al.,* 2014).

1.2 Problem Statement

The Musculoskeletal Symptoms (MSS) in industries often lead to disability and they involve the production workers in manufacturing industries. These workers are exposed in the manufacturing process to ergonomic hazards or risks. MSSs can be influenced by age, sex, height, weight, smoking status, and physical activity. It also found that MSSs cases at production at manufacturing industries is increasing every year (DOSH, 2016). It was found that by placing extra stress on the back of overweight workers seemed to increase the risk of low back pain (Shiri *et al*., 2009; Foong, 2014).

In most manufacturing industries, low back pain and shoulder pain are frequently described as high risks for production workers since they are exposed to a number of musculoskeletal symptoms which are often due to unwanted postures and motion (Silva *et al.,* 2017; Shiri *et al.*, 2009; Chandrasakaran *et al.,* 2003; Vyavahare, 2015; Chee *et al.*, 2004). Studies have shown that these disorders are caused by continuous support, reach, bend, push, pull and twist among the manufacturer workers. There is no observational tools carried out by any to evaluate the ergonomic risk among production workers at manufacturing industries especially risk assessment for entire body of a worker.

Ergonomic risk factors that are found related to musculoskeletal symptoms in manufacturing industries among production workers include forceful exertions, awkward postures and repetitions motion (Van Der Windt *et al.,* 2000). The factors that contributed to the risk of MSSs are defined as risk factors and it is something that leads to a damage or injury. At the same time, several ergonomic observational assessment tools are used to assess risk factors, but it is difficult to choose the best observational tool that is typical for production workers in manufacturing industries. This is because the different observational tools resulted different risk level in risk factors with supported questionnaire tool. So, with suitable observational tool, the risk factors can easily detect and understand the root of the risk by means of the best. Otherwise, in the future, the manufacturing workers may be facing these risk factors in the manufacturing industries.

1.3 Objective of Study

The objectives of this study are:

i. To determine the prevalence of Musculoskeletal Symptoms (MSSs) among production workers in manufacturing industries using self-report questionnaire.
ii. To evaluate the level of an ergonomic risk assessment using entire body Ergonomic Risk Assessments (ERA).
iii. To analyse the relationship between MSSs and level of ERA.

1.4 Scope of Study

The scopes of this study are:

i. Nordic Musculoskeletal Questionnaire (NMQ) is used in determining the prevalence of MSSs.
ii. Quick Exposure Check (QEC), Entire Body Risk Assessment (ENBORA) and Rapid Entire Body Assessment (REBA) are used in evaluating the level of ergonomic risk assessment.
iii. Focus on production workers at various manufacturing industries.
iv. The industries involved in this study are glass manufacturer industry, stevia ingredients manufacturer industry, water storage manufacturer industry, wood pallet industry, oil & gas utilities water & electrical utilities and furniture manufacturer industry.
v. This study was carried out on a sample of 252 production workers who work in a state that is not ergonomic such as prolonged standing, awkward postures, heavy lifting, repetition motions and forceful exertions.
vi. This study used mean, percentage, standard deviation (SD) and Chi-Square (χ^2) in the data analysis.

1.5 Significance of Study

This study is significant in developing great work environment at work place and support production worker's health. Workers who work in production as room attendants within manufacturing industries experience heavy physical work, repetition

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tasks and bad working posture during work which leads to Musculoskeletal Symptoms (MSSs). Employers have a legal obligation to protect the health and safety of their workforce. The employer can evaluate the risks to safety and health within the workplace and then, where necessary, improve the standards. This process is called risk assessment. A good risk assessment should cover all standard operations and reflect how the work is actually done. Production workers can also cooperate with their employer and supervisors in carrying out the risk assessment. Indeed, an employer can establish procedures to correct or control risk factors by providing work practices, such as proper lifting techniques and keeping workstations clean and ergonomically. An employer can also use administrative controls, such as worker rotation, more task variety, and increased rest breaks.

Great efforts by the employer also improve employee's participation and work performance which is another essential element for achieving success in an organization. In fact, by law, the employer must take care of the health and safety of the workers. The employer is responsible for evaluating the risks within the workplace and improving the standards of safety and health for all workers. Therefore, the tools and methods which will be used for this research are effective to determine the MSSs associated to the ergonomic risk factors among the room attendants in production site within manufacturing industries. Many of these methods are developed to assess MSSs risk factor exposure so that workplaces themselves could be responsible for MSSs prevention (Cole *et al.*, 2003). While ergonomics practitioners, occupational therapists, employers, union workers and health and safety authorities need information on the most effective assessment methods available for preventing MSSs, the literature still offers little applied research that had tested these methods in the field for comparison and lacks information on which methods were the best at preventing MSSs (Haukka *et al.*, 2010). Therefore, the first step to determine which method to choose is to test them in the field and compare their respective results.

1.6 Organization of the Thesis

Figure 1.2 shows the research organization which is as organized into five chapters consisting of introduction, review of literature, methodology of research, results and discussion, and finally conclusion and recommendation. Chapter 1 is an introduction

to this research that discusses the general background of the study among manufacturing workers related to MSSs problems.

In the performance of operational tasks, Chapter 2 of the literature review explains ergonomic problems. The information is retrieved from various sources such as thesis, newspapers, books, reports, etc.

Chapter 3 explains the methodology which is used to collect, evaluate and analyse data. The Nordic Musculoskeletal Questionnaire (NMQ) is used to collect data from manufacturing workers on work-related MSSs. However, Quick Exposure Check (QEC), Entire Body Risk Assessment (ENBORA) and Raid Entire Body Assessment (REBA) methods are used to assess production workers ergonomic risk factors.

In Chapter 4, after the survey was conducted, it discusses the results of this research. The results are acquired involving the method of NMQ, QEC, ENBORA and REBA, and the results are presented in tables or graphs. In NMQ, QEC, ENBORA and REBA methods, the correlation between characteristics and risk factors with musculoskeletal symptoms is identified.

The final chapter explains the conclusion that summarizes the findings throughout the thesis and recommendations for future enhancement research.

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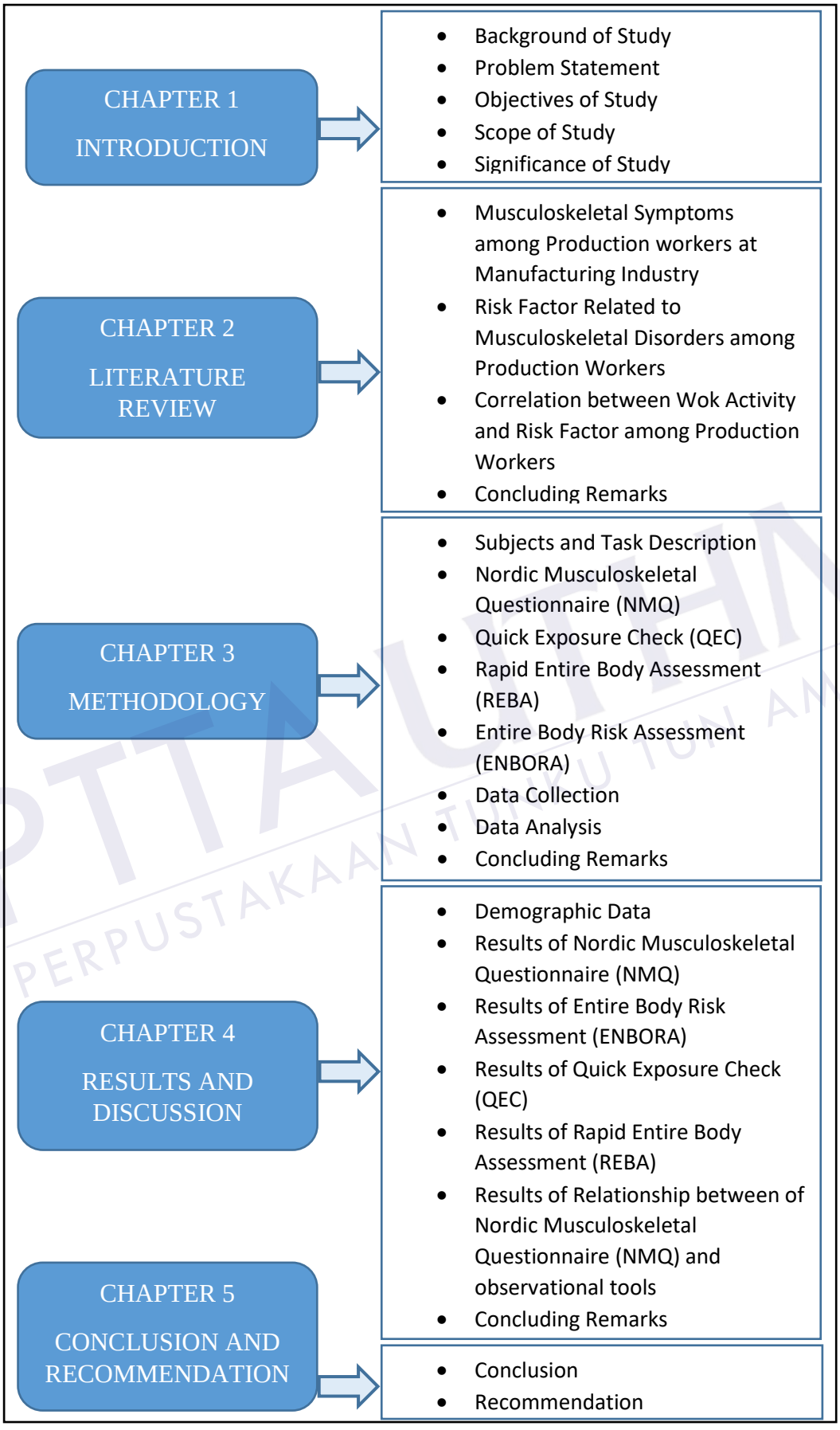

Figure 1.2: Flowchart of Thesis Organization

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter aims at re-examining and summarizing the study carried out in connection with operations in manufacturing sites. The musculoskeletal symptoms among production workers at manufacturing industry is explained in Section 2.2. Section 2.3 reviews the risk factor related to musculoskeletal symptoms among production workers. Section 2.4 describes the correlation between work activity and risk factor among production workers while findings related to MSSs are discussed in Section 2.5.

2.2 Musculoskeletal Symptoms among Production Workers at Manufacturing Industry

The highest prevalence rate of musculoskeletal symptoms was observed in the healthcare sector, followed by the manufacturing sector, as stated in the study by Choobineh et al., (2016). It also pointed out that corrective ergonomics measures should focus on these industries in order to eliminate or minimize musculoskeletal injuries at national level. Every manufacturing sector in Malaysia has many different sections with various types of production activities to boost productivity. The main role played by manufacturing workers was to ensure smooth operation of production activities such as operating CNC machines, transfer of materials, quality control and operation in the packaging section. During this time, the majority of the manufacturing workers encountered inappropriate working conditions which facilitated panic injuries

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